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Design and Fabrication of Equipment for Extraction of Coconut Milk from Shells

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***Abstract*—** *The purpose of this research was to develop and fabricate prototype of Coconut Grater- Milk Extractor Machine combining those two existing machines to produce the coconut milk. In current practices on the market today, in order to produce coconut milk, two separate machines are used such as coconut grater machine -to get grated pieces of coconut milk and then the coconut extracting machine - to get the coconut milk. More specifically, the aim of this study were: (1) To determine the extracting efficiency of the coconut grater - milk extractor machine. (2) To determine the time in grating and extracting of the coconut using a coconut grater - milk extractor machine. (3) To determine if there is a significant difference in the performance of the coconut milk extractor machine as compared to the existing means in terms of: a. Extraction Efficiency, b. Time to finish a specified amount of coconut to milk. The statistical tool used in the study were the mean and the t-test. Based on the data gathered, it was concluded that there is a significant difference between the mechanical coconut grater- milk extractor and the existing means. Further study is recommended to improve the extraction improve the efficiency of the machine.*

***Keywords*—** *Machine; Agriculture; Recovery; Product.*

I. INTRODUCTION

Coconut (cocos nucifera) is a member of the family arecaceae (palm family) and the only species of the genus cocos. It is one of the main sources of income for many coconut farmers especially in lowland places. The Philippines has about 2.9 million hectares of coconut plantation and one third of its population depends in coconut farming, production, processing and marketing for livelihood purposes. Coconut can be considered as one of the major crops in many provinces in the Philippines because of its abundant supply in the market. Many surveys conducted and have shown the entire parts of the coconut may be used for different purposes. Its fresh grated meat has many uses to food processing and households, particularly in preparation of pastries, cakes, production of coconut milk and oil to be used as important ingredients for many goods that can be seen in the markets. It was revealed by Banson (1982) that the fresh grated coconut is often used for food preparation. The coconut meat has to be grated and extracted to produce cream or oil.

Commercial extractors which uses the principle of compression is to costly, there units pricing of about 1000 dollars excluding delivery cost and taxes, and while the screw types pressers of extractors cost 450 dollars excluding delivery cost and taxes. This means that commercial extractor costs 20,000 to 70,000 of pesos per one unit. The high cost of the commercial extractors may probably turn back the users in to manual means which time and effort of extracting and sometimes the quality or the sanitation of the product is the main concern of this. The existing coconut graters and extractors are separated with each other, and the process of extraction is by means of compression which will not efficiently extract the milk from its meat because of some difficulties of the machine to operate and to compress small grated meat of the coconut. In order to minimize the effort of grating and extracting of coconut milk, high cost of other existing devices, and a lot of time consuming effort for grating and extracting hence, this are some reason why this study is conducted.

II. MATERIALS AND METHODS

2.1 Materials

1 hp Electric motor
Ø 12 in Pulley
1 ½ X ¼ Angle bar
4 X ¼ Flat bar
1 in Steel shaft
Perforated cylindrical Container
1 X ½ in Rectangular Tube
Ø 2.5 in Pulley
V-belt (B-69)
Knife Mill
1 in pillow blocks
Stainless steel basin
5 tons Hydraulic jack
Bearing
Rivets
Welding Electrode
Bolts, Nuts and Washer

2.2 Fabrication Procedure

The Mechanical Coconut Grater-Milk Extractor is to be fabricated by the following procedure below

1. Gather all the materials and tools needed.
2. Measure the materials to its specific design.
3. Cut the appropriate dimension of the angle and flat bar for the frame.
4. Join the prepared materials by means of welding to form the frame.
5. Mount the electric motor to the frame.
6. Fasten the knife mill and pulley directly to the electric motor shaft.
7. Fasten the pillow blocks with pulley on the frame and put v- belt in place.
8. For the extractor, weld the ram on the frame.
9. Weld the plate support for the base of cylindrical container on the hydraulic jack.
10. Aligned all the components according to the design.
11. Construct the lift arm of the hydraulic press then connect it the driving shaft.
12. Prepare for evaluation of the product.

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2.3 Evaluation Procedure

The machine is tested and evaluated by the following parameters:

1. Extraction Efficiency (by Theoretical) = (Actual mass / Ideal mass)* 100%

Where in:

Actual mass = mass of actual coconut milk extracted

Ideal mass = ideal milk extracted

$$= \left(\frac{63.7\ g_{milk}}{100\ g_{meat}}\right)(W_2)$$

W_2 = mass of grated coconut meat to be extracted.

2. To determine the time in grating and extracting of the coconut using a coconut grater - milk extractor machine, perform 3 trials
3. Tabulate the difference in the performance of the coconut milk extractor machine as compared to the existing means in terms of extracting efficiency and time.

2.4 Instrumentation

The study made use of an evaluation sheet containing the criteria for evaluation of the machine. Stopwatch was used in determining the time consumed in grating and extracting the coconut milk. Weighing Scale was used to weigh the mass of the coconut meat and the milk.

2.5 Statistical Data Analysis

The statistical data tool used in this study was the average or arithmetic mean and the t-test. The t-test was used to find out the significant difference between two means calculated based the independent variable or obtained under different conditions for the same population.

Formula for Mean:

$$M = \frac{\Sigma x}{N}$$

Where:

M= Arithmetic Mean

N = number of trials

Σx = sum of the results taken on N trials

To determine if there are significant difference between two treated variables, find out the relation between the $T_{computed}$ and the $T_{tabular}$. The t-test ($T_{computed}$) can be calculated using the formula:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\left(\frac{(N_1-1)(SD_1^{\,2})+(N_2-1)(SD_2^{\,2})}{N_1+N_2-2}\right)\left(\frac{1}{N_1}+\frac{1}{N_2}\right)}}$$

Where:

t = t-test

$\bar{X}_1$ = arithmetic mean of the first variable

$\bar{X}_2$ = arithmetic mean of the second variable

$SD_1^{\,2}$ = variance of the first variable

$SD_2^{\,2}$ = variance of the second variable

N1 = Number of cases of the first variable

N2 = Number of cases of the second variable

The tabular value $T_{tabular}$ = 2.132 is determined using a 5 % significance level and a degree of freedom of 4.

III. Results and Discussion

Extraction Efficiency of Mechanical Coconut Grater- Milk Extractor

TABLE 1. Extraction Efficiency of Mechanical Coconut Grater- Milk Extractor

Trials	Actual mass, g	Ideal mass, g	Efficiency,%
1	377	477.75	78.91
2	375	477.75	78.49
3	379	477.75	79.33
Mean	377	477.75	78.91

Table 1 below shows the extraction efficiency of the Mechanical Coconut Grater- Milk Extractor. The efficiency is obtained by diving the Actual mass (weight of extracted milk out of 750 g of coconut meat using the developed machine) by Ideal mass (weight of ideal milk extracted out of 750 g of coconut meat. After three trials, it was found out that the mean efficiency is 78.91 %.

Time to extract the coconut milk

Table 2 shows the extraction time of the Mechanical Coconut Grater- Milk Extractor using 750 g of coconut meat. It yield a mean of 3.64 minutes on 3 trials.

TABLE 2. Time to extract the coconut milk

Trials	Extraction time, min
1	3.63
2	3.57
3	3.72
Mean	3.64

Performance of Mechanical Coconut Grater- Milk Extractor versus the Existing Means in terms of Extraction Efficiency, %

Table 3 shows the mean of 78.91 for the Mechanical Coconut Grater- Milk Extractor and 77.59 for the existing means. Comparing the two means with the use of T-test; it was found out that the T-computed (2.67) is greater than T-tabular (2.132) which means that there is a significant difference between them.

TABLE 3. Performance of Mechanical Coconut Grater- Milk Extractor versus the Existing Means in terms of Extraction Efficiency, %

Trial	Mechanical Coconut Grater- Milk Extractor
1	78.91
2	78.49
3	79.33
Mean	78.91

Performance of Mechanical Coconut Grater- Milk Extractor versus the Existing Means in terms of Extraction time, min.

TABLE 4. Performance of Mechanical Coconut Grater- Milk Extractor versus the Existing Means in terms of Extraction time, min

Trial	Mechanical Coconut Grater- Milk Extractor
1	3.63
2	3.57
3	3.72
Mean	3.64

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Table 4 shows the mean of 3.64 for the Mechanical Coconut Grater- Milk Extractor and 4.05 for the existing means. Comparing the two means with the use of T-test; it was found out that the T-computed (4.239) is lower than T-tabular (2.132) which means that there is a significant difference between them. Table 1 below shows the percentage of recovery for 1 Kilogram coffee bean in terms of weight of coffee after hulling and weight of coffee before hulling. It was shown that in 1 kilogram of coffee bean in three trials the mean percentage of recovery in de-hulling is 65%. The data implies that the coffee de-huller machine can perform efficiently in terms of percentage of recovery used in hulling the coffee beans. Thus, it is more efficient to use the mechanized coffee de-huller than the previous study having a 50% mean efficiency by using manual operated coffee de-huller machine.

IV. Conclusions

The trial method was employed by the researcher which was within the realm of scope of conducting a true experiment. T-test was used to determine if there is significant difference between the performances of Mechanical Coconut Grater and the existing means.

Results of the study revealed that there is a significant difference between the mechanical coconut grater- milk extractor and the existing means. Considering the data and parameters involved during the conduct of the testing of the machine the researchers arrived to the following conclusions:

1. The machine yields a mean of 78.91 % extraction efficiency and a mean of 3.64 min extraction time.
2. The machine differed significantly to the existing means in term of extraction efficiency and time.
3. The machine is more efficient and time saving compared to the existing means.

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